DESCRIPTION OF THE AEOLID NUDIBRANCH *Favorinus tsuruganus* BABA AND ABE, 1964 FROM EASTERN AUSTRALIA

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ABSTRACT

Favorinus tsuruganus Baba and Abe, 1964 (Opisthobranchia: Nudibranchia) is redescribed from material taken in Queensland and New South Wales waters. Characters of its external anatomy, alimentary and reproductive systems (e.g., structures of propodial tentacles, ceratal arrangement, jaws, penis), as well as the behaviour of living animals agree well with those known not only for Japanese specimens but also for *Favorinus* species in general. The radular teeth are unusual, but not exceptional, in having smooth sides to the cusp. Coloration and shape of the rhinophores are the most distinctive features.

INTRODUCTION

The aeolid fauna of Australia is rich and diverse. Intense collecting by myself in Queensland over two years has revealed 51 species; a total that belies impressions of the rarity of aeolids in tropical seas (e.g., Miller, 1969). Aeolids are certainly encountered rarely in time and space in such latitudes (33 species from the above total are known to me by four specimens or less) when general collections of opisthobranchs are made. These nudibranchs are often found only on a specific food, and once this food has been located there is every likelihood that a particular species will be encountered. Statements as to the rarity of aeolids in tropical seas are based in general on relatively short sorties, and are accompanied by little knowledge of their particular foods and have come from shore-based workers. Collections of nudibranchs in a particular area over relatively long periods of time usually reveal large numbers of aeolid species (e.g., Risbec, 1928; 1953). I fully concur with Rudman (1979) that there is in fact high species diversity amongst the Aeolidacea in tropical seas.

Favorinus tsuruganus was first described from Japan from one specimen (Baba and Abe, 1964). Two further specimens enabled an extended redescription to be published later (Baba and Abe, 1975). This species is obviously rare in Japan. It appears to be relatively common, by aeolidacean standards, subtidally in Queensland and New South Wales — four specimens were collected between July 1980 and August 1981.

GENUS *Favorinus* M.E. Gray, 1850

Type species (by monotypy) *Eolis alba* Alder & Hancock, 1844 (= *Favorinus branchialis* Rathke, 1806) (I.C.Z.N., 1966).

The genus was traditionally at the hub of the family Favorinidae until it was amalgamated, along with the closely related Facelinidae, as two separate subfamilies within the enlarged family Glaucidae (Miller, 1974). An account of the somewhat tortuous history of the Favorinidae is given in Miller's paper.

Favorinus is an advanced aeolid genus in that there is no notal brim, the anus is cleioprotic and the certata are grouped into arches. About a dozen species of *Favorinus* have been described previously, more than half of them from the Pacific Ocean. One, *F. pannuceus* Burn, has a type locality in Victoria, Australia.

Favorinus tsuruganus Baba and Abe, 1964 (Fig. 1-15)

SYNONYMY

1964, Baba and Abe: 163-164, fig. 1; 1975, Baba and Abe: 117-120, fig. 1.

EXTERNAL MORPHOLOGY

The Australian specimens are described below to permit a complete comparison with Japanese material, to clarify the structure of the rhinophores, and to delineate *F. tsuruganus* from other described *Favorinus* species. The following account is based on four living specimens.

Animals have been up to 14 mm long when crawling in the fully extended state. The body and foot are elongate and the broad back is flattened in the midline. The foot is relatively wide; even so when the animal is crawling its foot remains obscured by the back and cerata. The foot is parallel-sided and pointed posteriorly, and the broad tail just extends behind the hindmost cerata. The largest specimen had a tail that was rounded posteriorly. At its anterior margin the foot is extended into a pair of narrow, backward-arching propodial tentacles. These tentaculate foot margins possess a longitudinal groove ventrally that extends down their entire length (Fig. 3), and are dorso-ventrally flattened and broader than the oral tentacles, but only half as long as these latter organs. The oral tentacles are round in cross section, very elongate and flexible, and they taper to sharp points apically. They are half as long again as the largest cerata on the back. After a week in captivity the oral tentacles of the smallest specimen regressed to stubs of equal length to the rhinophores, but no autotomy of the distal sections was indicated. The rhinophores are most distinctive. They consist of a tall axis which is blunt-tipped, and there are three large, equal-sized, overlapping flanges arising close to the middle of the rhinophore (Fig. 4). These flanges are thin, their upper margins are free from the axis and fluted, and they curve around the axis to join it anteriorly and posteriorly. During locomotion the rhinophores are held erect, tilted slightly forward and diverging at an angle of about eighty degrees. The rhinophores are quite flexible and can readily be contracted downwards when touched with a needle.

Anteriorly the first two clusters of cerata can be discerned as being grouped discretely (although the actual arrangement of cerata within these clusters is not able to be delineated from the living animal because they are so numerous). Behind the second cluster it is not possible to assign cerata to particular clusters in the living animal. The cerata are narrow and fusiform. Those closest to the midline arch slightly over the back; those towards the outsides of the clusters stand out obliquely from the body. The cerata are clustered in seven pairs of tight groups; they are arranged in arches towards the front of the animal, in rows in the hindmost two or three groups. Resolving their arrangement and numbers in preserved specimens proved a difficult task because many of them were autotomized during fixation in all the specimens. One specimen cast off several of its cerata when it was collected, but regeneration of most of them had begun one week later. The numbers of cerata per group that could be counted in two specimens are as follows. P indicates the position of the pericardium.

Specimen 1 (right side): 5; (P); 10; 11; 9; 6; 6; 3.

Specimen 2 (left side): 11; (P); 9; 8; 6; 4; 5.

The reproductive apertures are situated at the base of the first ceratal arch. The anus is cleioprotic, opening high on the right side within the second ceratal arch. It is situated a little rearwards of the centre of this arch (Fig. 2).

COLOUR

The back of the body and oral tentacles are opaque white. The foot is translucent white as are the propodial tentacles. The head is golden-yellow or brownish-yellow on both its dorsal and ventral surfaces. Dorsally this yellow colour extends from the bases of the oral tentacles rearwards to the bases of the rhinophores; ventrally it covers the head, mouth and lips, and reaches the anterior foot margin. The rhinophores are entirely black. The cerata have a translucent epithelium that lacks superficial pigmentation. Internally the digestive diverticulum, which is dense but somewhat more diffuse proximally, is orange. The cnidosac at the apex of each ceras is black (Fig. 5).

INTERNAL ANATOMY

The salivary glands are lobulate and very small. They consist of a short, broad duct and cluster of spherical acini (Fig. 9).

The penis (Fig. 15) is a simple "glans". It is U-shaped with the two limbs closely adpressed. It is relatively stout, unarmed, and pointed apically. The lower half of the distal limb is surrounded by a thin sheath which has been partially removed in the specimen illustrated.

RADULA (Figs. 7, 8, 10, 11)

Formula 0.1.0. The number of teeth in the four specimens I have examined are 17, 16, 14 and 14. All the teeth in the radula consist of a highly arched base with perfectly truncated posterior-lateral faces to the limbs, and a narrow, elongate cusp that projects well in advance of the base. Both sides to the cusp are completely smooth and the apex is very sharply pointed (Figs. 7, 10). In profile the lower surface of the cusp is seen to be straight whilst the upper surface is convex (Figs. 8, 11). Mature teeth nearest the growing end of the radula are 92 μm wide (distance measured between the two limbs of the base) and their cusps are 105 μm long.

JAWS (Figs. 6, 12-14)

The two jaws are large and well-cuticularised structures. Their shape is elongate-ovate, their length (0.92 mm) is almost double their maximum width (0.50 mm) (maximum width measurement excludes masticatory border). The jaws meet anteriorly at narrow, rounded apices. The ventral margin is smooth and evenly convex. The thin dorsal margin is expanded anteriorly, and there is a broad, pronounced indentation at the anterior third. The ventral side carries a prominent, wide, much-thickened masticatory border which is 0.70 mm in length and free for one-quarter of that distance. The border is narrow anteriorly and widens progressively posteriorly to reach its maximum width in front of the free posterior section. The border bears numerous, thickened, upstanding denticles along its entire length (Figs. 12-14); those at the outer margin being tallest (up to 30 μm in height) — these denticles are tall, parallel-sided and erect. There are numerous (approx. 5) rows of denticles along the masticatory border, they decrease progressively in height so that those most remote from the outer margin are merely low granules.

MATERIAL EXAMINED

NEW SOUTH WALES

1 specimen (11 mm extended crawling length), found on the undersurface of a stone, on substrate of clean coarse sand, 7.6 m, "The Nursery", northern side of Julian Rocks, off Cape Byron, northern New South Wales, R.C. Willan, 13 July 1980.

QUEENSLAND

1 specimen (14 mm), found crawling over rubble, 12 m, at base of drop off, S.E. corner of larger islet, Shag Rocks, N.W. of Point Lookout, eastern side of North Stradbroke Island, southern Queensland, R.C. Willan, 7 August 1981; 2 specimens (both 13 mm) found together beneath the same dead coral slab, 13.7 m, N.N.W. face of Shag Rocks, N.W. of Point Lookout, eastern side of North Stradbroke Island, southern Queensland, M.P. Ready, 5 December 1980.

ADDITIONAL RECORDS

Mr R. Burn has kindly supplied me with three additional locality records: 1 specimen, 9-12 m, Broadhurst Reef, off Townsville, Queensland, I. Loch, November 1974 (Australian Museum, C 96579); 1 specimen, Coffs Harbour, northern New South Wales, August 1979; 1 specimen, shallow subtidal, Green Point, Sydney, New South Wales, R. Kuiter, 20 April 1977 (Australian Museum, C 106238).

GEOGRAPHICAL AND BATHYMETRIC RANGES

Favorinus tsuruganus is now known in eastern Australia from Townsville, Queensland to Sydney, New South Wales. It would appear to be commonest in the centre of that range i.e., from Coffs Harbour to North Stradbroke Island.

Present records indicate *Favorinus tsuruganus* is essentially a subtidal species with maximum abundance between 6 and 13 metres. However it is quite probable that some individuals will be taken intertidally on rare occasions.

ECOLOGY

The species apparently occurs in open situations where there is clean, silt-free water. In these environments it occurs on substrates of coarse sand or shell rubble. No direct observations have been made of the feeding by this aeolid. Mr R. Kuiter noted the Sydney specimen ate the eggs of other opisthobranchs when it was in captivity in his home aquarium. This behaviour is not at all surprising in view of the known predilection, or possibly even dependence, of other *Favorinus* species for opisthobranch spawn (documented for *Favorinus* sp. from the Solomon Islands by Miller (1969), for *Favorinus branchialis* by Brown & Picton (1979) and for *F. japonicus* by Gosliner (1980) and Bertsch & Johnson (1981)).

REMARKS

This aeolid conforms well with the glaucid genus *Favorinus* on account of the cleioprotic position of its anus, six or seven groups of cerata arranged in arches (both pre- and post-cardiac groups), simple penis, and several rows of large denticles arranged along the masticatory border of the jaw. Most other described species of *Favorinus* have short cutting edges to the radular teeth and serrated or denticulate margins to the cusps of the teeth. By contrast, *F. tsuruganus* has an extended, narrow cusp with smooth edges. These radular characteristics serve as significant distinguishing points but are by no means unique within the genus, for example smooth-edged cusps also occur in *F. japonicus* (Baba, 1949; Gosliner, 1980) (although I note a discrepancy here in that Rudman (1979) reports this same species to possess denticulate margins). What does appear peculiar to *F. tsuruganus* is the presence of three large, overlapping flanges on the rhinophores. All *Favorinus* species have rhinophores that carry ornamentation of some type. Other species belong to two series according to the structure of the rhinophores. Firstly there are those with regular swellings (or "bulbs") along the rhinophoral axis (*Favorinus branchialis* (Müller), *F. auritulus* Marcus, *F. blianus* Lemche & Thompson, *F. gouaroi* Risbec, *F. ghanensis* Edmunds, *F. japonicus* Baba, *F. pannuceus* Burn, *F. vitreus* Ortea); and secondly there are those with lamellate rhinophores (*F. perfoliatus* Baba, *F. mirabilis* Baba, *F. joubini* Risbec, *F. violaceus* Risbec). Whilst being completely distinctive, the rhinophoral structure of *F. tsuruganus* suggests it lies closer to the second group.

Not only are the anatomical features of this aeolid typical of *Favorinus*, it has in addition

two behavioural characteristics (both already noted) shared by its congeners — notably ceratal autotomy and the habit of eating the spawn of other opisthobranchs. *Favorinus tsuruganus* also exhibits the fast-moving activity and restless disposition typical of glaucids (Miller, 1974).

The bright coloration of *Favorinus tsuruganus* is thoroughly distinctive, being rather more intense than the majority of other *Favorinus* species (*F. japonicus* and *F. perfoliatus* are notable exceptions). No other *Favorinus* has orange cerata with black tips as does *F. tsuruganus*. The jet black colour of the large (one could almost say bulky) rhinophores means *F. tsuruganus* is distinguishable at once. *Favorinus ghanensis* has purple-brown or maroon rhinophores with pale apices (Edmunds, 1968). *F. joubini* has maroon rhinophores with red tips and *F. violaceus* has pinkish rhinophores which became dark violet distally (Risbec, 1953). Both of these latter species were described initially for New Caledonia. The Japanese species *F. mirabilis* has dark brown rhinophores. The only aeolid which has any resemblance to *F. tsuruganus* in coloration is the European facelinid *Caloria elegans* (Alder & Hancock). This resemblance is merely superficial — the latter species has deep orange (almost brick orange) cerata with a black subapical zone. The apex of each ceras bears a single white spot.

Australian specimens of *Favorinus tsuruganus* agree so closely with those described from Japan that there can be no doubt they belong to the same species. Because the Japanese specimens were slightly larger they had more teeth in the radula (27 rows for a 20 mm animal, and 16 rows for the 15 mm holotype) but the tooth structure itself matches precisely. It now appears that the holotype was unusual, or possibly aberrant, in possessing only two flanges on the rhinophores (described as "two bulbs" by Baba and Abe, 1964) since all the later specimens, both from Japan and Australia, have had three flanges (described subsequently as "three cups" by Baba and Abe, 1975).

NOTE ADDED IN PROOF: Four additional specimens of *Favorinus tsuruganus* were found by me early in 1983. The largest one measured 22mm. Two were feeding on a spawn coil of *Hoplodoris nodulosa;* the others were feeding on the spawn of a large tritoniid nudibranch. These observations confirm *Favorinus tsuruganus* principally eats the eggs of other nudibranchs.

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I am grateful to Mr R. Burn for supplying me with locality records for this aeolid and providing additional information on *Favorinus pannuceus*. Both Mr Burn and Dr M.C. Miller kindly read the manuscript. Mr M.P. Ready collected two of the specimens. The scanning electronmicrographs accompanying this paper were taken by staff of the University of Queensland's electron microscope centre. Funding for my surveys of Queensland opisthobranchs has generously been provided by the Australian Biological Resources Survey, Canberra.

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Fig. 1. *Favorinus tsuruganus*. Length 14 mm. Specimen from 12 m, S.E. corner of Shag Rocks, off Point Lookout, North Stradbroke Island, southern Queensland. Leg. R.C. Willan, 7 August 1981.

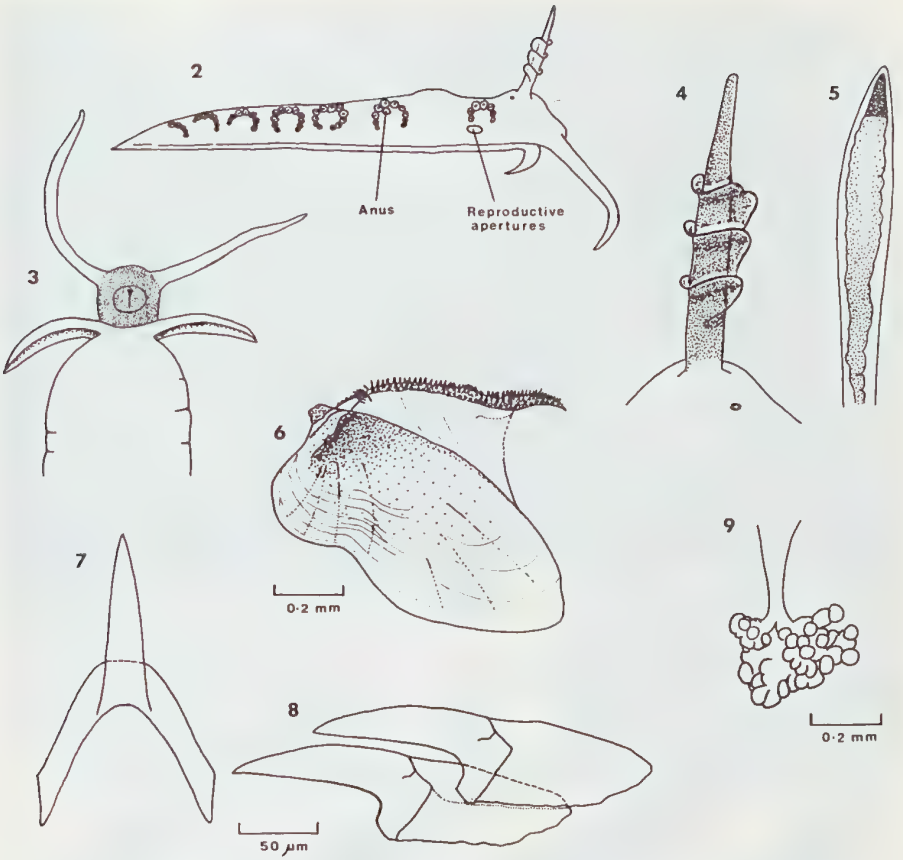


Fig. 2-9. *Favorinus tsuruganus:* 2, diagrammatic right profile showing the insertion of the cerata and position of the anus and reproductive apertures; 3, ventral view of the head and anterior foot margin (drawn from life: stipple represents yellow pigmentation); 4, detail of left rhinophore from the outside; 5, detail of a single ceras from a living animal showing orange digestive diverticulum and black apex; 6, left jaw (view of the inner surface); 7, dorsal view of single radular tooth (13th); 8, left profile of two radular teeth (5th and 6th); 9, salivary gland.

Figs. 7 and 8 drawn to same scale.

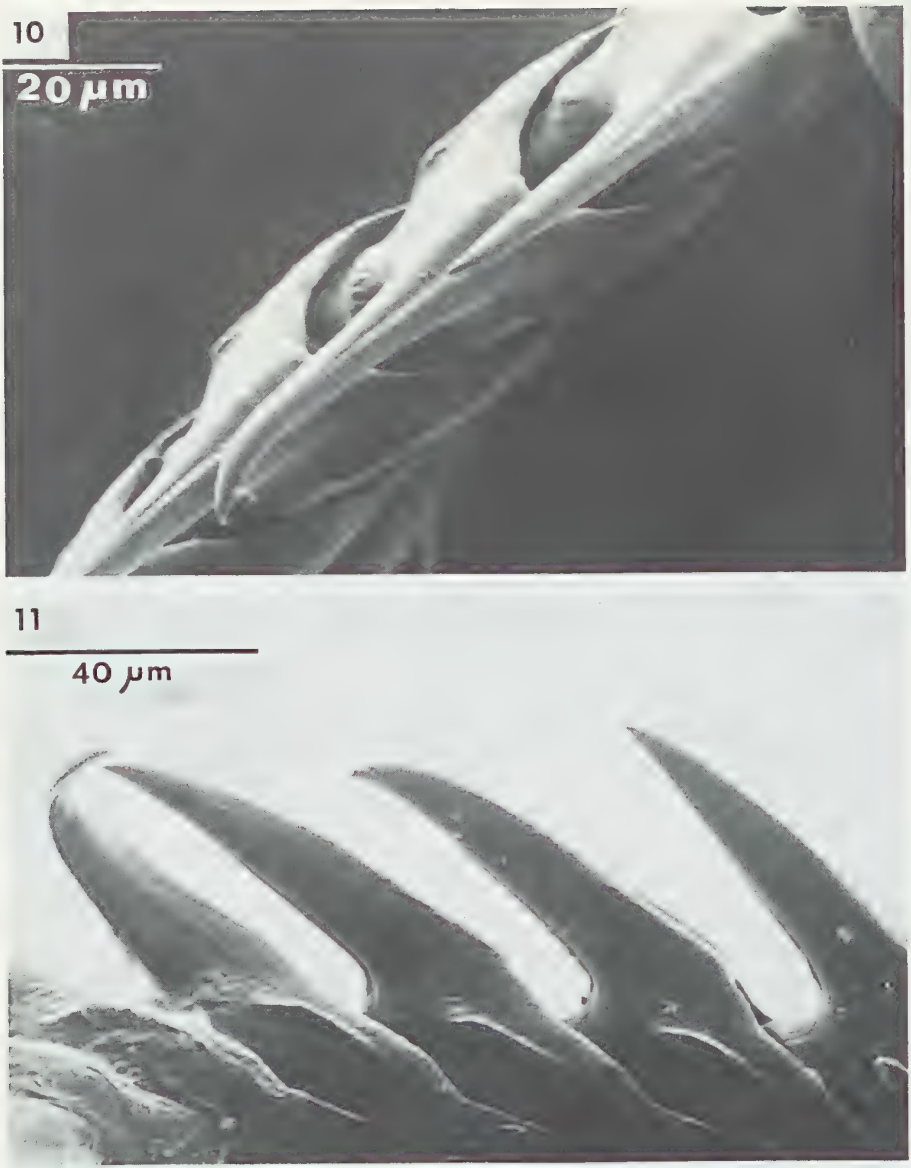


Fig. 10, 11. Radula of *Favorinus tsuruganus:* 10, dorsal view of teeth (2nd to 4th) at the youngest end of radula; 11, same teeth as Fig. 10 but seen in profile.

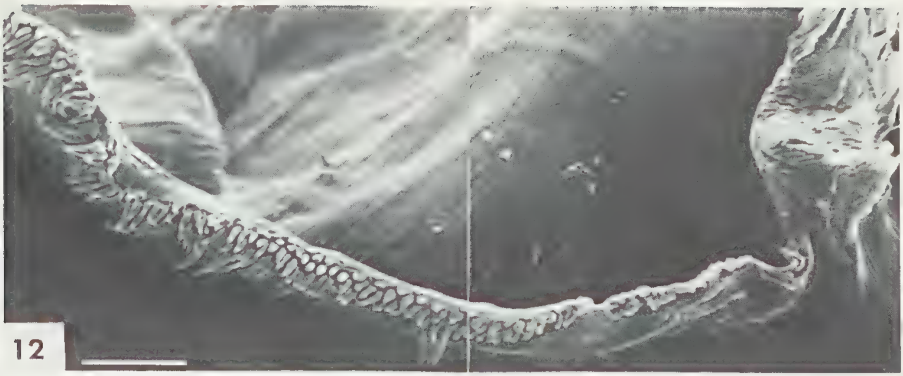
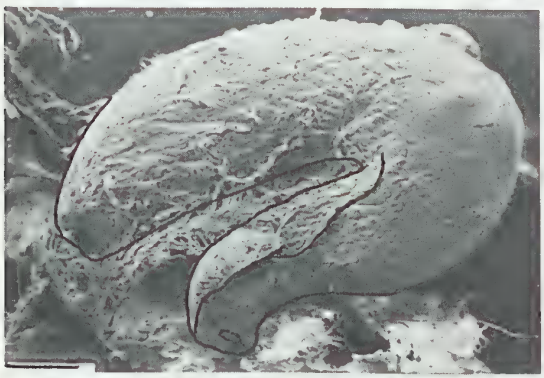


Fig. 12-14. Masticatory elements from jaw of *Favorinus tsuruganus:* 12, S.E.M. montage depicting inner face of left jaw and proximal section of masticatory border along vental surface; 13, distal (free) section of masticatory border from same jaw. Figs. 12 and 13 to same scale, bar represents 20 μm; 14, detail of denticles along masticatory border, x 1800.



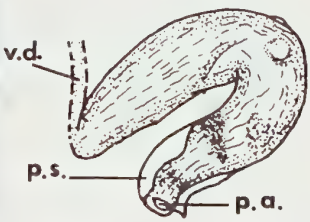


Fig. 15. Penis of *Favorinus tsuruganus;* left profile, penial sheath removed from around distal section of penis. Scanning electronmicrograph on left; specimen prepared by critical point drying technique. Explanation in sketch on right: p.a. — penial aperture; p.s. — penial sheath; v.d. indicates insertion of vas deferens onto back of penis (not visible in S.E.M.).